ANTARCTIC EXPLORATION.

By A. Mault.

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Antarctic exploration is no new subject for discussion at the meetings of the Royal Society of Tasmania. Our founder was the hero of Arctic research, and our records contain papers by another of our distinguished Fellows—the *facile princeps* of Antarctic explorers, Sir James Ross—of whose expeditions Hobart was the base of operations. In later times one of the best records of Antarctic exploration up to date is contained in the paper read before us in 1886 by the late Deputy Surveyor-General, Charles Sprent. That paper is so complete a history of what had been done that I should not have again called your attention to the subject but for the additional information that has lately been obtained in connection with voyaging among ice under conditions totally different to those under which Ross achieved so much. The information is derivable from papers that have been recently read, and discussions that have taken place upon them at the meetings of the Royal Geographical Society and the Royal Scottish Geographical Society. I need hardly say that the new conditions under which voyaging among ice floes and bergs is being done are those connected with the use of steam.

Up to the present time no properly equipped and constructed steam vessel has crossed the Antarctic circle. The *Challenger* is the only steam vessel that has crossed the circle; and, as she was not intended for service in high latitudes, she was wholly unprotected for ice work. But the experience gained by the Dundee and Norwegian steam whalers during the 1892-93 season in the neighbourhood of Graham's Land and the South Shetlands, just north of the Antarctic circle, show very clearly under how much more favourable conditions Antarctic research can now be undertaken than when Cook and Weddell and Ross penetrated beyond the 70th parallel of south latitude.

Here is Ross's account of how he had to encounter a storm in the ice on January 19, 1842:—"At 9 p.m. the wind suddenly freshened to a violent gale from the northward, compelling us to reduce our sails to a close-reefed maintopsail and storm staysails: the sea quickly rising to a fearful height, breaking over the loftiest bergs, we were unable any longer to hold our ground, but were driven into the heavy pack under our lee. Soon after midnight our ships were involved in an ocean of rolling fragments of ice, hard as floating rocks of granite, which were dashed against them by the waves with so much violence that their masts quivered as if they would

fall at every successive blow; and the destruction of the ships seemed inevitable from the tremendous shocks they received. By backing and filling the sails, we endeavoured to avoid collision with the larger masses, but this was not always possible; in the early part of the storm the rudder of the *Erebus* was so much damaged as to be no longer of any use; and about the same time I was informed by signal that the *Terror's* was completely destroyed, and nearly torn away from the stern post. We had hoped that, as we drifted deeper into the pack, we should get beyond the reach of the tempest; but in this we were mistaken. Hour passed away after hour without the least mitigation of the awful circumstances in which we were placed. Indeed, there seemed to be but little probability of our ships holding together much longer, so frequent and violent were the shocks they sustained; the loud crashing noise of the straining and working of the timbers and decks, as she was driven against some of the heavier pieces, which all the activity and exertions of our people could not prevent, was sufficient to fill with dismay the stoutest heart that was not supported by trust in Him who controls all events; and I should commit an act of injustice to my companions if I did not express my admiration of their conduct on this trying occasion; throughout a period of 28 hours, during any one of which there appeared to be very little hope that we should live to see another, the coolness, steady obedience, and untiring exertions of each individual were every way worthy of British seamen. The storm gained its height at 2 p.m. when the barometer stood at 28·40 inches, and after that time began to rise. Although we had been forced many miles deeper into the pack, we could not perceive that the swell had at all subsided, our ships still rolling and groaning amidst the heavy fragments of crushing bergs, over which the ocean rolled its mountainous waves, throwing huge masses one upon another, and then again burying them deep beneath its foaming waters, dashing and grinding them together with fearful violence. The awful grandeur of such a scene can be neither imagined nor described, far less can the feelings of those who witnessed it be understood. Each of us secured our hold, waiting the issue with resignation to the will of Him who alone could preserve us and bring us safely through this extreme danger; watching with breathless anxiety the effect of each succeeding collision, and the vibrations of the tottering masts, expecting every moment to see them give way, without our having the power to make an effort to save them."

Compare with this the following extracts from a paper read at the Royal Scottish Geographical Society's meeting at Edinburgh, in January of this year, by Mr. W. S. Bruce, naturalist to the steamship *Balæna* during the expedition of

1892-3 :—"Like our predecessors, we found it to be a region of gales and calms—gales from the north, with wet fog; gales from the south, with blinding snow; calms with fog, and calms with brilliant sunshine." Then, after giving a glowing description of a beautiful Christmas eve, he proceeds :—"This is the picture of a calm midnight in midsummer, different, indeed, from the heavy weather we experienced at other times, when for days we sheltered behind bergs and streams of pack during black nights thick with fog and snow. One of the gales we encountered the skipper described as the hardest that ever blew in the Arctic and Antarctic; and, indeed, it was stiff. For ten hours we steamed as hard as we could against it, and at the end had made only one knot. Picture to yourselves a sailing vessel: What a different agency we have now! Where Cook, Ross, Weddell, and others would have been in the greatest peril, we with steam were comparatively safe."

And Dr. Donald, of the same expedition, after referring to Ross's experiences of storms in the stout old *Erebus* and *Terror*, speaks in terms similar to those of Mr. Bruce as to the changed conditions due to steam.

But it is not only with regard to safety in storms that the use of steam has altered the conditions under which Antarctic exploration can be undertaken, it is a yet more important factor in connection with the power it gives to take advantage of opportunities and to contend with circumstances. Polar navigation, and especially Antarctic navigation, is the subject of what, until we know more of the laws that govern seasons and climatic and other conditions that affect it, we must call luck or good fortune. For instance, in 1823 Weddell found a clear sea which enabled him to push his little cutter to the 75th deg. of south latitude, four degrees farther than the limit fixed by Cook when he said, "I can be bold enough to say that no man will ever venture farther than I have done." And yet when Ross with his well found ships tried to surpass Weddell, he could on the same longitude get only to the 65th parallel. And again in 1841 Ross entered the main pack south of Campbell Island at the 67th parallel of latitude and got through it in four days. The next year he encountered the pack in 61 deg. 15 min., and it took him forty-four days to get through it. Now amidst all this uncertainty as to the conditions in which the polar ocean will be found there can be no doubt Ross did all that a skilful and daring seaman could do with the means at his command, and it is beyond all praise that he did so much. But what if he had had steam power? During all that terrible gale in the pack he so wonderfully describes in the extract I have given, the S.S.W. wind was driving him, together with the pack, back to the northward. If he could have done what the *Balæna* did last

year, and held his own, the pack would have soon drifted past him. At the discussion on Dr. Murray's paper on Antarctic exploration read at the Royal Geographical Society's meeting on the 27th November last, Sir R. Vesey Hamilton said that with a steamer Ross's forty-four days in the pack would probably have been reduced to four. And he went on:—"I believe now that the amount of work that was done by Sir James Ross in three seasons could be done in one season with modern steam power, and I have some knowledge of ice navigation, having been three winters and five summers in the Arctic regions. Now the greatest enemy to a sailing ship is a gale in the ice heavily packed, as we have seen from the diagrams; then the ships are in great peril, perhaps for steam as well as sailing ships; but after the gale comes a calm, when the ice opens out and the steamer would immediately make rapid progress, while the sailing ship might be unable to move for some days."

And it is not only in cases like these mentioned by Sir Vesey Hamilton, that sailing ships are at a disadvantage. The readers of Sir James Ross's account of his voyages will come over and over again to passages describing how calms and contrary winds or currents baffled the great navigator at most critical times when a coastline had to be left unexplored or an opening in the ice left unentered. Had it been possible to have taken advantage of these lost opportunities, how much might the bounds of our knowledge of Antarctic regions been enlarged.

I have shown on the accompanying chart what, with regard to certain subjects, are the bounds of our present knowledge of those regions. It is based on information given in Dr. Murray's charts—our greatest authority on the subjects referred to. As regards the conformation of the coasts of Antarctic land or lands, what is known is distinguishable from what is hypothetical by difference of shading; and sources of the knowledge are shown by the tracks of all navigators known to have crossed the Antarctic Circle. Their voyages are well summarised in Mr. Sprent's paper recorded in our transactions. The chart also shows the bathymetric curves, and the summer temperature curves of the circumpolar ocean and air—important factors in relation to Antarctic exploration.

With respect to what has already been done in Antarctic regions by far the most important performances were those of Weddell in 1823, and of Ross in 1841 and 1842. Weddell's track, between 30 deg. and 40 deg. of west longitude, traverses the deep basin of the South Atlantic, and he did not get much beyond the 2,000 fathom curve. The relatively warm water that exists in the deeper parts of the Antarctic ocean probably accounts for the open water Weddell found. Sir

James Ross describes the upthrow of this warm layer of water caused by the southerly submarine current from the tropics meeting the gradual rise of the sea bottom as it approaches land. And Dr. Murray, in the paper already referred to, says that "these deep layers of relatively warm water appear likewise to be slowly drawn southwards to the Antarctic area, to supply the place of the ice-cold currents of surface water drifted to the north. This warm underlying water is evidently a potent factor in the melting and destruction of the huge table-topped icebergs of the Southern Hemisphere." The difference between the temperature of the surface and underlying water in the deep basin crossed by Weddell is shown by Ross's sounding in it when he reached no bottom with a 4,000 fathom line, and when with a surface temperature of the water of 30·8 deg. he found a temperature of 39·5 deg. at 1,050 fathoms—the greatest depth to which he could trust his self-registering thermometers.

Ross's tracks within the Antarctic Circle in 1842 and 1843, between 170 deg. east and 160 deg. west longitude, took him across no such deep basin, for the soundings varied from about 1,600 fathoms on the Circle to 150 as he approached land. But the influence of the warm underlying current from the north was always noticeable, the temperature of 39·8 deg. being repeatedly found at 600 fathoms with a surface temperature below freezing point; and at his farthest south, with soundings of only 250 fathoms, the shoaling had brought the warmer water to the surface where its temperature was 32 deg. with a mean air temperature of 27 deg. The temperature of the sea at the bottom was 33·2 deg.

In a conversation I had the other day with Captain Pascoe, he incidentally mentioned another factor that may have much influence in keeping an open sea in the neighbourhood of Ross's tracks in 1841 and 1842. These tracks pass along what is probably the main line of the earth's volcanic and seismic action in the southern hemisphere—the line marked by the New Zealand volcanoes and Mount Erebus. Earth tremors would certainly do much to help forward the action of the water on the great ice barrier that guards the coast of Victoria Land.

It must always be borne in mind that our knowledge of Arctic regions enables us to predicate very little in connection with Antarctic. The circumstances of the two poles—and especially the meteorological circumstances—are so entirely, and, at present, so unaccountably, different, that reasoning from Arctic data is almost inevitably misleading with relation to Antarctic facts and conditions. All navigators who have been in both are continually recording how unlike the one polar region is to the other. Many of the meteor-

ological conditions are, with our present knowledge, quite unaccountable. For instance, why should the barometric pressure be so much less in the south than in the north? There is probably half an inch of mercury of difference. The effects of this are very evident in the southern zone of south-westerly winds with rain and snow all round the globe, but what is the cause? Again, we have all read of the short but for the time genial summer of the Arctic regions—why is there none in the Antarctic? Ross, when close to the great Victoria land ice barrier writes:—"Gigantic icicles depended from every projecting point of its perpendicular cliffs, proving that it sometimes thaws, which otherwise we could not have believed; for at a season of the year, eqvivalent to August in England, we had the thermometer at 12 deg., and at noon not rising above 14 deg.; this severity of temperature is remarkable also when compared with our former experience in the northern seas, where from every iceberg you meet with streams of water are constantly pouring off during summer.

Another remarkable phenomenon connected with what should be the Antarctic summer is the very small range of the temperature both diurnal and seasonal. In Ross's book the abstract meteorological journals given show for January, 1841, a maximum daily range of 12 deg. Fah. and a minimum one of 1 deg.; and for February, 1841, a maximum daily range of 10·5 deg. and a minimum of 1·5 deg. And last year Mr. Bruce had similar experience in the *Balæna*. He says in the paper from which I have already quoted:—"The records of air temperature are very remarkable; our lowest temperature was 20·8 deg. Fah., our highest 37·6 deg.—only a difference of 16·8 deg. in the total range for a period extending slightly over two months. Compare this with our climate, wherein a single day and night you may get a variation of more than twice that amount. . . . The average temperatures show a still more remarkable uniformity. December averaged 31·14 deg. for 115 readings; January, 31·10 deg. for 198 readings; February, 29·65 deg. for 116 readings—a range of less than $1\frac{1}{2}$ deg. Fah. From these records of temperature Mr. Bruce and Dr. Murray and other authorities think it very probable that there is a comparatively small range of temperature all the year round in Antarctic regions, and that the cold of winter would not be so terrible as is imagined by some.

The result of the great amount of precipitation taking place in the zone of low pressure and in a summerless climate, is that the whole coastline of land within the Antarctic Circle is covered with an icecap of enormous thickness. But from observations of the prevailing winds in the south polar regions, it is almost certain that the zone of low barometric

pressure and its accompanying great precipitation does not extend to the pole. Dr. Murray, in the paper we have already quoted from, says:—"It is probable that about 74 deg. S., the belt of excessive precipitation has been passed, and it is even conceivable that at the pole precipitation might be very little in excess of, or indeed, not more than equal to, the evaporation." It is, therefore, very likely that instead of the thickness of the snow or icecap on the Antarctic lands being 10 or 20 miles as estimated by the late Mr. Croll, Dr. Murray's estimate of 1,800 feet as the maximum is nearer the truth, as this estimate slightly exceeds the calculated thickness of the greatest southern bergs and floating ice islands.

In consequence of this all-prevailing mantle of frozen snow, "no land animal and no trace of vegetation--not even a lichen or a piece of seaweed—has been found on land within the Antarctic Circle." The whalers last year brought back some fossils, probably from tertiary rocks, that "distinctly indicate the existence of more genial conditions within the Antarctic in past geological times."

But as Dr. Murray says:—"When we turn to the waters of the Antarctic ocean we find at the present time a great profusion of life, both animal and vegetable. During the *Challenger* expedition myriads of minute spherical tetrasporæ were observed to give the sea a peculiar green colour over large areas. Diatoms were frequently in such enormous abundance that the tow nets were filled to the brim with a yellow-brown slimy mass, with a distressing odour, through which various crustaceans, annelids, and other animals wriggled. . . . Occasionally vast quantities of copepods, amphipods, etc., were observed to give the ocean a dull red colour. . . . . These small crustaceans are in turn the chief food of the fishes, penguins, seals, and whales which abound in the waters of the great Southern Ocean." How abundant and varied the animal life of this part of the ocean is may be judged from the fact that Dr. Murray mentions that the *Challenger* trawl and dredge obtained from waters lying farther south than Tasmania 326 new species, and 119 new genera from depths varying from 1,260 to 2,600 fathoms, and that one-half of the new species and a quarter of the new genera were not obtained elsewhere.

Now what is to be done in the matter of Antarctic exploration? Dr. Murray answers:—"A dash at the South Pole"—(like that which Nansen is making at the North)—"is not what I now advocate, nor do I believe that is what British science at the present time desires. It demands rather a steady, continuous, laborious, and systematic exploration of the whole southern region, with all the appliances of the modern investigator. This exploration should be undertaken by the Royal Navy. Two ships not exceeding 1,000 tons should, it

seems to me, be fitted out for a whole commission, so as to extend over three summers and two winters. Early in the first season a wintering party of about ten men should be landed somewhere to the south of Cape Horn, probably about Bismarck Strait, at Graham's Land. The expedition should then proceed to Victoria Land, where a second similar party should winter, probably in Macmurdo Bay, near Mount Erebus. The ships should not become frozen in, nor attempt to winter in the far south, but should return towards the north, conducting observations of various kinds along the outer margins of the ice. After the needful rest and outfit at the Falklands, or Australia, the position of the ice and the temperature of the ocean should be observed in the early spring, and later the wintering parties should be communicated with, and, if necessary, reinforced with men and supplies for another winter. During the second winter the deep-sea observations should be continued northwards, and in the third season the wintering parties should be picked up and the expedition return to England. The wintering parties might largely be composed of civilians, and one or two civilians might be attached to each ship; this plan worked admirably during the *Challenger* expedition.

In the discussion which followed the reading of Dr. Murray's paper, and in which Sir Joseph Hooker, the Duke of Argyll, Sir George Nares, Sir R. Vesey Hamilton, Captain Wharton, Lord Charles Beresford, Sir Wm. Flower, and others took part, general agreement was expressed with Dr. Murray's plan of campaign, and much enthusiasm was shown. If any doubts were expressed about the commercial utility of such an expedition, none were possible as to the priceless advantages that would accrue to science from it. Its popularity would be immense both in the Navy and in the scientific world, and the difficulty of manning the expedition would only be the embarrassment of choice.

At the Royal Scottish Geographical Society's meeting in January, after papers by Mr. Bruce and Dr. Donald on the scientific results of last year's whaling trips to the South Shetlands, a resolution was passed to send a memorial to Government in favour of a national expedition.

I have purposely avoided saying anything directly bearing on the commercial aspect of the question as to the desirability of sending such an expedition, because I think that is not our business. Commerce can and ought to take care of itself. And if we as a nation only sent out expeditions where we were sure beforehand of success from a commercial point of view, no interest would have suffered so much as the commercial interest of the Empire. Thorough scientific exploration has usually been followed as a natural consequence by commercial development. In this case the scientific

interests are so important as to fully justify their being regarded as of such national concern as to require a special expedition. The *Erebus* and *Terror* were fitted out virtually only to obtain information with regard to terrestrial magnetism—that science is now as much in need of further information as it was then. And all the other sciences I have incidentally mentioned are equally interested. And with reference to all these sciences, in addition to our general interest, we have in Tasmania a particular one especially in connection with terrestrial magnetism, for we could probably offer the nearest site to the south magnetic pole for a permanent magnetic observatory. I hope that in connection with the revived interest in Antarctic research, and perhaps in connection with the Leake astronomical bequest and our University, such an observatory may be re-established in Hobart as that which did such good work under Ross and his successors.

In conclusion, I may claim to be consistent with regard to my opinion that this work should be done by the Royal Navy. A year or two ago I had the honour to stand and vote alone in this room in opposition to a proposed subvention from the Australian colonies to aid Baron Nordenskjold's projected Antarctic expedition, on the ground that it was a national matter and should be undertaken by the Royal Navy. I think so still; but as I then explained I included in the Royal Navy the Australian contingent, and I hope that if one can be made suitable for ice work, one of the two proposed vessels will belong to the little fleet to which we all contribute.